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COMPOSITE, ITS USE, AND METHOD FOR ITS PRODUCTION

Specification

INS B1

~~The invention relates to a composite material for forming a liquid-retaining layer in a hygiene article or a medical product, having a first layer of substantially continuous staple fibers with a diameter of 15 to 35 μm, and having a second film layer.~~

Composite materials of nonwoven and film components are known, for instance in the field of disposable hygiene articles.

As the backing sheet material of these hygiene articles, the only recourse previously was to plastic films, but this lent the hygiene article an increasingly unacceptable plastic-like appearance. Today, two-layer nonwoven and film laminates are increasingly used as a backing sheet of these hygiene articles, as disposed for instance in European Patent Application EP 0 187 728 B1: The film component located on the inside substantially takes on the sealing function while the nonwoven component located on the outside is intended to lend the backing sheet a fibrous, textile-like appearance. As the nonwoven component, spunbonded nonwovens or card nonwovens are preferably used, which are produced on the basis of relatively course fiber material (diameter > 15 μm).

From German Patent DE 44 29 251 C2, an at least two-layer laminate construction is known, comprising a textile

backing layer and a further film layer. No staple fiber layer is provided.

German Patent Application DE 41 08 937 A1 discloses a composite nonwoven material, formed of a mixture of fine microfibers and what by comparison are course filaments, as well as the use of this composite nonwoven material as a cover layer, facing toward the body, of a hygiene article.

From International Patent Disclosure WO 97/16148, a liquid-retaining layer of a three- or four-ply fiber composite material is known, using either one spunbonded nonwoven layer and two melt-blown layers or spunbonded nonwoven layers and melt-blown layers in alternating order. A film layer is not provided.

From International Patent Disclosure 96/07376, a hygiene article with a liquid-retaining layer is known, comprising a film layer or a microfiber layer and a structure-forming fiber layer joined to it that has a hot-melt adhesive component.

However, it has been found that besides its visual and tactile advantages, this fibrous, textile-like design of the backing sheet of a disposable hygiene article also has considerable disadvantages, both subjectively and objectively. That is, the users of these hygiene articles, who previously were accustomed to a simple but smooth film as a backing sheet, often perceive the fibrous backing sheet material as excessively rough.

There is also the risk, while this hygiene article is being manipulated, for instance when diapering a baby, that

items of jewelry, such as rings or watches, may become caught in the fibrous surface structure of the backing sheet material, which can even be destroyed as a result.

When the known nonwoven-film laminate is used as backing sheet material of a disposable diaper and at the same time the by now widely used hook-and-loop elements are used, the hook elements of the closure strip not only get into the target region intended for them, which is typically a plush material placed in the stomach region on the outside of the backing sheet, but also undesirably catch everywhere on the fibrous surface of the backing sheet material.

INS B2

~~It is therefore an object of the invention to create an improved composite material that particularly from the standpoint of use as a backing sheet material in disposable hygiene articles precludes the known disadvantages.~~

~~This object is attained by a composite material as defined by the characteristics of claim 1.~~

The middle layer, sandwiched in between, comprises substantially continuous thermoplastic fibers or filaments, deposited relatively randomly in the spinning process, with a diameter of 15 to 35μm. The spinning process for producing spunbonded nonwoven fabrics has long been known to one skilled in the art and therefore requires no special explanation here. For creating the staple fiber layer, polymers selected from the group comprising polyolefins, polyamides, polyesters, polyurethanes, and also corresponding copolymers can also be used.

An outer layer is made from long microfibers with a

diameter < 10 μm, by the melt-blown process also familiar to one skilled in the art. If the composite material is used as the backing sheet of a hygiene article, this layer would preferentially come to be located on the outside. For creating the microfiber layer, once again polymers selected from the group comprising polyolefins, polyamides, polyesters, polyurethanes, and also corresponding copolymers can for instance be used.

The microfibers are applied according to the invention directly to the staple fiber layer by the melt-blown process. As a consequence, the microfibers penetrate the surface structure of the staple fiber layer and form a coating of what, viewed in detail, is the three-dimensionally structured surface of the staple fiber layer.

In the preferred case, the microfiber layer has a weight per unit of surface area of only about 5 g/m², and seen in cross section it follows that three-dimensional fibrous surface structure of the middle staple fiber layer; in other words, it penetrates the structure of this layer three-dimensionally.

A staple fiber and microfiber layer structure is already known from published, nonexamined German Patent Application DE-OS 23 56 720. For production reasons, however, the microfiber layer does not penetrate a three-dimensional staple fiber layer. Instead, a very discrete phase transition, which is homogeneous in the plane of the laminate, can be discerned.

European Patent Disclosure EP 0 403 840 B1 also shows a staple fiber and microfiber structure, but it is

characterized by a uniform mixture of the two types of fibers, so that no phase boundaries can be discerned any longer; instead, complete and thorough mixing of the components exists over the entire cross section.

In contrast to this, in the present invention, there is no homogeneous mixture of the two fiber materials over the cross section. In macroscopic terms the microfibers form a film-like structure, which is placed in the manner of a very closely contacting skin over the fibrous surface of the staple fiber layer, thus reliably preventing unintended catching and entanglement of the staple fibers on sharp-edged elements, such as the hooks of a hook-and-loop closure system, are reliably prevented.

It has been found that the risk of unintended catching on sharp-edged elements is markedly reduced whenever the hook peel-off force, relative to the microfiber layer that forms the outside of the composite material, is less than 20 cN/25 mm, and preferably less than 10 cN/25 mm, and especially preferably less than 5 cN/25 mm. The retention forces, above called hook peel-off forces, are defined and measured as described below. For the test, a 25-millimeter-wide test strip of a hook material is used that can be procured under catalog number CS 200-900 ppi, xMH-4123 from Minnesota Mining and Manufacturing in Neuss, Germany. This test strip is applied at a contact pressure of two kilograms to the opposite surface to be tested, in this case the surface of the microfiber layer, using a roller device. To that end, the composite material is fixed on a rigid holder. The holder is fixed to a tension testing device, and the test strip is clamped to a tension jaw, resulting in a peel-off angle of 150°, which in the peeling-off process decreases

slightly by a few degrees. As the retention force or peel-off force is being measured, the test strip is peeled off from the counter part surface at a constant speed. The measured peel-off force is plotted as a function of the travel distance.

With the invention, the roughness of the staple fiber layer, which is perceived as unpleasant, is also decreased. At the same time, the fibrous structure of the staple fibers is also visible through the very thin microfiber layer, so that from this outside of the material composite, a textile-like impression, perceived both visually and tactilely, is still obtained, as before.

The penetration of the microfiber layer into the staple fiber layer furthermore has the advantage that for a given weight per unit of surface area of the composite material, a higher level of strength is attained.

For better bonding of the fiber layers, the composite can advantageously be solidified in a manner known per se by means of many spot-like bonds created by a combination of pressure and temperature. One of these spot-like bonds preferably has an expansion per unit of surface area of no more than 0.5 mm^2. There should be no more than 45000 of these bonding points per square meter, to allow the composite material to drape properly.

The other one of the outer layers is formed by the plastic film, which substantially takes on the sealing function in the case where the composite material is used as a backing sheet in hygiene articles. The plastic film is preferably also produced from a thermoplastic polymer

selected from the group comprising polyolefins, polyesters, polyamides, polyurethanes, or corresponding copolymers.

In a preferred embodiment of the invention, the plastic film likewise penetrates the fibrous, three-dimensional structure of the staple fiber layer. Because at least the microfiber layer three-dimensionally penetrates the fibrous structure of the spunbonded nonwoven, there is a mean spacing between the outer layers that is less than the thickness of the staple fiber layer, if this thickness is defined as the greatest distance in the composite material, perpendicular to the surface plane of the composite material, between the surfaces of the staple fiber layer.

Such preparation techniques as the production of suitable cuts, optionally microtome sections, optionally after the composite material is embedded in a polymer that lends high integrity to the composite material, and microscopically reinforced methods of analysis for determining the aforementioned measurement variables, are familiar to one skilled in the art and therefore require no more-detailed explanation here.

Particularly with a view to the use of the material as a backing sheet and hygiene articles, the composite material in a further preferred embodiment of the invention is embodied as breathable. That is, it has a breathability of at least 500 g/m² over a period of 24 hours, as ascertained by German Industrial Standard DIN 53122, sheet one. At the same time, when used as a backing sheet and hygiene articles under the wearing conditions that then prevail, the composite material should be liquid-proof; that is, it should not allow any water in liquid form to pass through it. The term

liquid-proof in this sense is understood to mean a water column of at least 250 mm, ascertained by DIN EN 20811.

The composite of the two fiber layers can be considered to be breathable per se. Thus a breathable film material should be selected as the film component of the composite material. These materials are known to one skilled in the art (see for instance German Patent 3121040 and German Published, nonexamined Patent Application DE-OS 3306843; G. Pinchard, "Breathable Films" presented at the Absorbent Products Conference, October 17, 1996, in San Antonio, Texas, USA. In principle, the possibility exists of using a film provided with micropores, in order to lend water vapor the capability of penetrating mechanically, or of using foils that allow water vapor to penetrate by chemisorption, as has long been known for cellophane films, for instance. If a microporous film is used, then the pores - assuming an idealized round shape of the pores in terms of their geometry - preferably have an average diameter of 0.2 to 10 μm.

In a further preferred embodiment, the composite material has macropores at least in some portions. Macropores are understood to mean any kind of openings, regardless of their geometry and regardless of how and when the openings are made. In the case where the material composite is used as a backing sheet in hygiene articles, the macropores assure an exchange of air between the skin of the wearer and the outside of the hygiene article. The individual macropores preferably have a projection area of at least 0.1 mm^2 but at most 5.0 mm^2; the proportion of open area should be no greater than 25 percent.

The presence of macropores can be limited to the film

component of the material composite. This is particularly true if the microfiber/staple fiber composite already has a sufficiently high air permeability. However, the macropores can also be embodied in the microfiber/staple fiber composite; in that case these are preferentially pores that are present in the form of openings extending through all of the composite material.

INS B3

~~The object is furthermore to disclose a method for producing a composite material of the invention. This further object is attained by a method having the characteristics of claim 20.~~

~~Further characteristics, details and advantages of the invention will become apparent from the accompanying claims and the drawing and the ensuing description of a preferred embodiment of the composite material of the invention and of a method for its production. Shown in the drawing are:~~

~~Fig. 1, a sectional view perpendicular to the plane of a composite material of the invention;~~

~~Fig. 2, a section as in Fig. 1, on a larger scale;~~

~~Fig. 3, an apparatus for producing a composite of a staple fiber layer and a microfiber layer;~~

~~Fig. 4, an apparatus for applying a film layer to the composite made in accordance with Fig. 3; and~~

~~Fig. 5, a second embodiment of an apparatus for applying a film layer to the composite made in accordance with Fig. 3.~~

Fig. 1 shows a composite material, comprising a film layer 2 that forms an outer side, an inner staple fiber layer, and a microfiber layer 6 applied to the staple fiber layer 4 by the melt-blown process.

As can be seen from Fig. 1 and from the enlarged view in Fig. 2, the microfiber layer 6 penetrates the surface structure of the staple fiber layer 4 three-dimensionally and forms a coating that covers this surface structure and that as a consequence of the nature of the microfiber layer brings about a certain smoothing of the surface of the staple fiber layer 4.

If the spacing D_i of the side facing inward of the microfiber layer 6 is determined by the also inward-facing side of the film layer 2 at various points i and is determined in accordance with the equation $(D_1 + D_2 +...+D_i)/i = D'$, then this mean spacing D' is less than the thickness D_{Sp} of the staple fiber layer, if this spacing is defined as the greatest distance between two points of the outward-pointing surface of the staple fiber layer perpendicular to the plane of the composite material.

In Figs. 3 and 4, the production of the composite material of the invention is explained.

First, in a known manner, a staple fiber layer 4 is formed. The melting of a thermoplastic polymer, the expulsion of the molten polymer through suitable spinning nozzles, the stretching of the filaments, for instance by an air stream, and the cooling down and delivering of the filaments to a deposition system 10, preferably an endless screen belt 12 advancing continuously in one direction, are

effected by means of a spinning unit 8.

In the preferred case, before being deposited onto the screen belt 12, the filaments are cooled down to such an extent that substantially no thermally fused bonds occur where the filaments that are present after they have been placed on the screen belt intersect. Onto this still unconsolidated, as yet uncompacted and hence open staple fiber layer, which has a three-dimensional surface structure, the microfiber layer 6 is applied, preferably in an integrated production line, by a melt-blown unit 14 by the known melt-blown process. By means of high-speed hot-air streams, the filaments emerging from the polymer melt directly below the spinning nozzles are stretched to a very small diameter (< 10 μm) and are often also torn apart, thus forming microfibers that are more or less long in proportion to their diameter but in practical terms are virtually endless. These microfibers are deposited continuously directly onto the open staple fiber layer 4, so that the microfibers can three-dimensionally penetrate the surface structure of the staple fiber layer. Next, the fiber layers 4, 6 formed are compacted and solidified by a calendering device, that is, by the application of pressure and temperature, and wound onto a master roller 18. If the calendering device 16 has an embossing roller, then the aforementioned especially compacted, spot-like regions are formed.

In a second method step, the microfiber/staple fiber composite thus formed is either lined on the staple fiber side with a prefabricated film (Fig. 4), or else the film is extruded directly from a polymer melt onto the prefabricated fiber composite (Fig. 5).

In the first case, the microfiber/staple fiber composite and the prefabricated film 2 are paid out continuously from a master roller 18 and 20 and delivered to a calendering unit 22. At least one of the calender rollers 24 is heated in such a way that at least the film 2, in the press gap of the calendering unit 22, is brought at least in some portions to a temperature above its softening point or melting point. This creates fused bonds between the film 2 and the microfiber/staple fiber composite, and the film 2 can three-dimensionally penetrate the surface structure of the staple fiber layer 4.

In the second case shown in Fig. 5, the film 2, as already explained, is extruded directly from the polymer melt by an extruder 30 onto the microfiber/staple fiber layer advancing continuously beneath the extruder. In this preferred case, reinforced by a solidification station 32 following the extrusion, the film material, which at the moment of its application to the fiber composite is still molten and thus viscous, penetrates the three-dimensional surface structure of the spunbonded nonwoven layer 4.

The solidification station 32 advantageously comprises a pair of rollers 34. The roller 36 aimed at the film surface is advantageously an antiadhesion roller, such as a silicone-coated roller, while the roller 38 aimed at the surface of the nonwoven is designed as a cooling roller.